# REPORT OF THE COMMITTEE ON OFFICIAL STANDARDS OF WATER ANALYSIS[1]

Your Committee on Official Standards of Water Analysis has endeavored to go over the available material on the subject of water supply standards, with particular attention to experience with standards as proposed in America, and has also endeavored to obtain information relative to the opinion of representative workers on the general applicability of standards, especially that standard known as the United States Treasury Department standard for water supplied by common carriers to passengers in interstate traffic.[2]

The difficulties in the way of a fully successful general standard, based upon the results of analyses alone, seem to your committee to be insurmountable, at least in the light of our present knowledge. It is easier to conceive of a standard for the operation of a water plant, or for a series of similar sources in a very narrowly restricted area, but even then, if the analytical standard is made rigid enough to be significant, provision must be made to apply it with discretion.

The chief value of fixed standards lies in the simplification of the administrative control of water supplies, in the preparation of guarantees of filter performance and in the facilitating of the attempt to explain technical details to a non-technical body or to the public. A high standard of relative purity may be required in an arbitrary manner, and in the effort to meet the standard plant operators may bring about a general improvement in water supply conditions, as has resulted from the establishment of the United States Treasury Department standard with its governmental prestige. Any such standard must be used with discretion and with good judgment. In the hands of those who wish to use the standard in a rule-of-thumb manner without taking into consideration all known factors, a fixed standard may become a dangerous weapon,

[1] Submitted to the Executive Committee, June 24, 1920, and ordered printed in the JOURNAL. Discussion is desired and should be sent to the Editor.

[2] Bacteriological Standard for Drinking Water (Approved October 21, 1914) Public Health Reports, vol. 29, no. 45, 2959 (Nov. 6, 1914).

able to destroy the good name of a satisfactorily conducted water supply. The United States Treasury Department standard was originally promulgated in 1914[2] as a hard-and-fast, laboratory-controlled standard, but in 1919[3] it was found advisable to modify it to include other details and to allow for a certain degree of elasticity not contemplated in the original work.

Before any attempt can intelligently be made to prepare a standard, it is obvious that all factors capable of influencing the quality of water supplies should be known, and the likelihood of the result being influenced by outside conditions allowed for.

Among the many factors capable of influencing the analytical work, the manner of collecting the sample, the time in shipment, and the temperatures and light conditions to which the sample is subjected are important. In the analytical work itself must be considered the methods employed, the types of determinations made, those which are significant and those which are irrelevant. The accuracy of the various methods is to be weighed, and the results stated accurately. It is generally appreciated, for example, that the statement, "B. coli absent," is practically valueless, since the matter of the kind of media, the quantity of the water examined, period and temperature of incubation, and the extent of the confirmatory tests are all essential information.

Then, too, it is necessary that a standard procedure be decided upon and generally followed for each method selected, and that the meaning of the values obtained in these determinations to be relied upon, be much more accurately known. This having been accomplished, the question of the relative weights to be applied to the indications of the different results must be settled upon.

As has been shown, the state[4] and the city or plant[5] laboratories are by no means in agreement as to the exact methods to be employed for the individual determinations. And this is in spite of the fact that the Standard Methods of Water Analysis (A. P. H. A.) have been recognized for years.

[3] Amendment No. 8 to Interstate Quarantine Regulations of January 15, 1916, amending Section 13 of above regulations. Amendment dated July 14, 1919.

[4] Morse and Wolman, Journal of the American Water Works Association, vol. 5, no. 3, 198 (September, 1918).

[5] Hinman, Journal of the American Water Works Association, vol. 5, no. 2, 133 (June, 1918).

The present Standard Methods of Water Analysis are prepared by committees of the American Public Health Association with the assistance of committees of the Society of American Bacteriologists, the American Chemical Society, and the referees of the Association of Official Agricultural Chemists. The work was begun about 1895, earlier work having been done by the American Association for the Advancement of Science.

While committees of the American Water Works Association do not coöperate in the preparation of the report, the committees chosen by the other bodies have included members of this organization. Of those who have worked on the preparation of the various editions of the Standard Methods, A. P. H. A., fourteen are members of this Association at the present time (list of September, 1919). These are Edward Bartow, J. W. Ellms, George W. Fuller, Allen Hazen, D. D. Jackson, George A. Johnson, E. O. Jordan, H. E. Jordan, W. P. Mason, W. F. Montfort, Earle B. Phelps, R. S. Weston, George C. Whipple, C.-E. A. Winslow. These men are probably among those most likely to be selected by this organization for similar work, although it is true that they were chosen and their work accepted by another body and one which is not exclusively concerned with the problem of water supply. It must be remembered, however, that that organization is concerned with sanitation and the protection of health, rather than with the economics of furnishing water.

The work of these committees has been good, and has received general recognition. The chemical methods have been, perhaps, more satisfactory than the bacteriological methods, due, of course, to the fact that bacteriology is a very young science compared to chemistry. The chief objections to the latter methods as recommended have been the somewhat rapid change in procedure, the apparent influence of the personal preferences of the committeemen, and the adoption of a few procedures out of accord with the current water works practice. At the present time, while the committee on bacteriological methods does not include any members of this society (list of 1919), its work has apparently involved only the addition of a few of the newer bacteriological methods to the fourth edition of Standard Methods of Water Analysis. This edition is fresh from the press. Of these new processes, the ones most likely to influence the current practice are the recommended change to the phenol red method of titration of media, and the adoption of 0.5 per cent sugar broths instead of the older 1 per cent sugar.

Your committee believes that the objectionable features outlined above are necessarily unavoidable in collections of methods of this nature and sees no valid reason why this organization should attempt to formulate any standard methods of water analysis at this time. Your committee recommends that the Association accept the Fourth Edition of the Standard Methods of Water Analysis (A. P. H. A., 1920) as official.

Your committee would recall your attention to the value of frequent sampling of water supplies, and to the grave possibilities of error when too much dependence is placed on the results of a single examination. It is true that water-treatment-plant operators usually appreciate the advantage of repeated examinations, but small plants and those which supply well waters are apt to rely on examinations at too infrequent intervals.

It is evident that the present tendency in the bacteriological examination of water is to test larger and larger quantities for the presence of the B. coli group, but at the same time to narrow down the group of organisms included under that designation, as well as to further subdivide the group into the fecal and non-fecal type organisms.

Coupled with this tendency is the tendency to reduce the expression of the results of tests for the B. coli group to some short numerical form. There are a number of methods of calculating the probable number of these organisms per cubic centimeter or per 100 cc. They do not usually yield comparative results. The schemes of this sort which are probably the best known are the Phelps[6] and the McCrady[7] procedures. That of Phelps having been used in governmental work and being given in the Standard Methods of Water Analysis is probably the method in greatest use in the United States. According to Phelps' own statement, his method is of no value for single samples, but is useful where long series of results of plant operation are to be evaluated. It has been shown[4] that in order to be accurate within 20 per cent several hundred samples must be examined and their results treated by the Phelps method to get the number of B. coli per 100 cc. Moreover the dilutions must be so chosen as to yield a positive and at least one negative on each series of tubes representing a sample of water. Attention is directed to the massing of samples when the Phelps method is used

[6] Phelps, Proceedings American Public Health Association, vol. 33, 9 (1907).
[7] McCrady, Journal of Infectious Diseases, vol. 17, no. 183 (July, 1915).

and to the fact that it is sometimes undesirable to extinguish individual differences.

Your committee would, therefore, recommend that unless at least 100 samples are comprised in the series under consideration, the B. coli index be not reported, and that where an adequate series is considered, the number of samples in the series, together with the dilutions used, be stated. For smaller numbers of samples, some method which does not represent the same degree of fictional accuracy is recommended. A common method of reporting is to express the percentage of positive tubes for each dilution, at the same time giving the number of samples and the number of tubes of each dilution planted. Another common method is the fractional method, in which the denominator of a fraction represents the number of tubes planted and the numerator represents the number of positive tubes. Obviously the fraction for each dilution-size is given, together with the number of samples.

On account of its governmental prestige, the United States Treasury Department standard has perhaps been more generally accepted in the United States than any other standard. It has become the fixed standard of six states and one state has adopted the standard of the United States Department of Agriculture. This standard is based upon that of the Treasury Department, but includes other requirements based on sanitary chemical analyses, "special significance being attributed to the presence of nitrites, free ammonia in excess of 0.05 milligrams per liter and to an undue amount of organic matter." Other state water laboratories use the Treasury Department standard in a less rigid manner, although when doing work on railroad water supplies it is necessary to follow the governmental requirements.

The satisfaction of the plant operators seems to vary directly with the ease with which their particular plants can meet the standard. This is natural. However, the number of plants of towns over 25,000 which claim to meet the standard 100 per cent of the time is rather surprising. It is probable that many smaller plants cannot do so. A number of the better-informed plant operators remain opposed to the arbitrary standards. In some places the objection is to the count requirement, it being claimed that the bacterial count at 37°C. is liable to rapid increase in water of somewhat elevated temperature, and that in this case, as in others, an exact relationship between the sanitary quality of a water and

its bacterial count is apparently non-existent. The more general difficulty is with the requirements regarding the B. coli group organisms. In many cases where river water is chlorinated, types of gas-formers very resistant to chlorine but giving the test for the B. coli group recommended by the Treasury Department, are found.

While the United States Treasury Department standard was claimed at the time of its promulgation to apply only to the water supply of the trains, and any intention to extend the standard to municipal supplies was emphatically disclaimed,[8] the effect of the condemnation of the supply of a community and the posting of notices in the stations declaring the water unsafe has been to create a local pressure which has in many instances forced the improvement of the local supply. This is a matter of great and far-reaching importance in which it is evident the arbitrary standard of the United States Public Health Service has done much good. To what extent the methods of handling the water and of filling tanks on coaches have negatived the precautions and improvements is not a matter within the province of the committee.

It is probable that the Treasury Department standard has at the same time worked some hardship on some large water plants in the United States, which were producing a safe water as judged by the typhoid rates of the communities. The elasticity provided for in the amendment of 1919 should aid in avoiding such difficulties.

In 1914 the committee of the New England Water Works Association on Statistics of Water Purification recommended[9] classifying water supplies according to the extent of the analytical control of operation as follows:

Class 1: Analyses one or more times per day. Engineering data collected and one or more attendants constantly employed.

Class 2: Analyses made regularly once a week or month by trained analyst. Attendant in charge makes simple tests daily.

Class 3: Irregular and infrequent analyses. No daily tests.

It is obvious that in considering the "structural, environmental and operative" conditions, larger factors of safety should be required for plants operating under class 2 or 3.

[8] Jordan, et al, Proceedings Indiana Sanitary and Water Supply Association, vol. 8, 38 (1914).

[9] Report of the Committee on Statistics of Water Purification, Journal of the New England Water Works Association, vol. 28, 220 (1914).

The importance of the sanitary survey in water supply investigations can hardly be overstated. It is so easily possible to conceive of the submission of selected samples, or of samples that do not represent the usual output of a water plant, or even of a well supply, that the value of the collection of data on the supply, an inspection on the ground, and the collection of samples by an observer trained in these matters is easily appreciated. He may locate possibilities of trouble that although long familiar with the plant, the operators have not seen, and he may suggest easy and effective means of avoiding the danger.

In checking over the results of a recent survey of railroad water supplies in Iowa the following figures were obtained as to the agreement between the examination made in accordance with the United States Treasury Department method and the sanitary survey made by an experienced officer of the United States Public Health Service.

*Water supplies in Iowa*

| SUPPLIES SATISFACTORY | SUPPLIES UNSATISFACTORY | | |
|---|---|---|---|
| By both survey and examination | By both survey and analysis | By survey, analysis satisfactory | By analysis, survey satisfactory |
| *per cent* | *per cent* | *per cent* | *per cent* |
| 67 | 18 | 9 | 6 |

More significant than this has been the work by the Division of Sanitation, Minnesota State Board of Health[10] since the Minnesota work covers a longer period and includes the results upon a much larger number of supplies. The results given in the following table of unsatisfactory supplies were based on the investigation of 1119 water supplies, of which 730 were found to be unsatisfactory in their existing condition.

*Unsatisfactory water supplies in Minnesota, 1912–1918*

| | UNSATISFACTORY WATER SUPPLIES | SHOWN UNSATISFACTORY BY | | |
|---|---|---|---|---|
| | | Field survey and analysis | Field survey | Analytical results |
| Number | 730 | 354 | 338 | 38 |
| Per cent | 100 | 49 | 46 | 5 |

[10] Whittaker, Journal of the American Water Works Association, vol. 7, no. 2, 278 (May, 1920).

Your committee would therefore recommend to the members of this Association that they insist upon a thorough and complete sanitary survey, to be made, by preference, by the person who is to make the analysis or interpret the analytical findings, before any important report is made upon the plant under their control, whether the report is to be made by national, state or municipal authority, or for the information of the management of the plant. It is further recommended that in the matter of the routine or irregular examinations made by an analyst not regularly on duty at the plant, that the analyst be fully informed of any changes or unusual conditions which have occurred in the interval between his visits to the plant.

Your committee, after full consideration of the question, cannot recommend any series of values as standard values for all classes of waters, nor for the waters of one class throughout America.

In making this recommendation it is not unmindful of the important influence of some arbitrary standards, nor of the possibilities of recent work on the operation of filter plants. In the judgment of the Committee such progress as is likely to be made soon in the matter of standards, is likely to come in the control of water plant construction and performance standards.[11, 12]

The committee would therefore submit the following as its definition, not of a "standard" water, but of a satisfactory one:

A water which is reasonably free from noticeable color, odor, taste and turbidity, which is reasonably free from objectionable salts in solution, which is free from injurious effects upon the human body, and which is produced and distributed in such a manner that its quality is practically certain to be maintained continuously in spite of accidents which can be expected in the operation of the plant.

Respectfully submitted,

JACK J. HINMAN, JR.,
H. A. WHITTAKER,
ABEL WOLMAN,
E. M. CHAMOT.

[11] Horton, American Journal of Public Health, vol. 7, 380 (1917).

[12] Wolman, American Journal of Public Health, vol. 6, 1153 (1916), Journal of the American Water Works Association, vol. 5, 272 (1918); Journal of the American Water Works Association, vol. 6, 444 (1919).